Airway Management

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OBJECTIVES

Upon completion of this chapter, the OEC Technician will be able to:

9-1 List the major anatomical structures of the upper airway.
9-2 Describe and demonstrate how to manually open the airway or mouth using the following techniques:
   a. Head tilt-chin lift
   b. Jaw thrust
   c. Crossed finger
9-3 Describe how to clear a patient’s airway using the following methods:
   a. Gravity
   b. Finger sweep
   c. Suction
9-4 Describe how to place a patient into the recovery position.
9-5 Compare, contrast, and demonstrate the usage of a rigid suction catheter and a flexible suction catheter.
9-6 List the indications of and uses for the following airway adjuncts, and demonstrate the proper methods for choosing the correct size and inserting them:
   a. Oropharyngeal airway
   b. Nasopharyngeal airway
9-7 Describe how to calculate the oxygen flow duration rate.
9-8 Describe and demonstrate how to properly set up an oxygen tank for use.
9-9 List four tips for the safe use of oxygen.

Chapter Overview

Having an open airway and adequate respiration is the most important factor for preserving homeostasis because every cell in the body depends on a constant supply of oxygen. This is why assessment of the airway and breathing is first in a primary assessment. Under normal conditions, the airway is open and clear, which permits the free and constant exchange of gas between the environment and the lungs.

HISTORICAL TIMELINE

1953: NSP incorporated in Colorado
1956: William R. Judd becomes first elected National Director of NSP

continued
The human body is susceptible to a variety of physical, medical, and traumatic conditions that can adversely affect the breathing process. When problems occur, they must be managed quickly and effectively in order to restore respiration, because without a continuous source of oxygen, death occurs rapidly.

As members of the emergency care system, OEC Technicians are specifically trained to provide medical care to patients under austere conditions in remote outdoor settings (Figure 9-1). Because OEC Technicians typically arrive at a patient’s side well before other care providers, they must be able to assess a patient’s airway quickly and immediately correct any problems that are discovered. As part of this process, technicians must be prepared to open, clear, and maintain the airway using a variety of methods. Technicians also must be able to deliver supplemental oxygen whenever it is indicated and stand ready to provide artificial ventilations if either spontaneous respirations are not observed or the patient’s breathing efforts are ineffective. Each of these skills, fundamental to the OEC curriculum, can be life saving, and therefore we must become proficient in them.

An understanding of the principles and practices of airway management is crucial to an OEC Technician’s ability to apply this information effectively in an emergency situation. Oxygen administration, airway maintenance, and ventilation assistance are essential skills that every OEC Technician must master.

**Anatomy and Physiology**

The airway is divided into upper and lower components. The upper airway begins at the mouth and nose and ends at the larynx (Figure 9-2). In between are the **pharynx** and **epiglottis**. The pharynx is subdivided into three parts: the nasopharynx, oropharynx, and the laryngopharynx. The nasopharynx, better known as the nasal cavity, warms and humidifies air as it enters the body. The hairs in it remove small particles to prevent them from entering the trachea and lower airway. The oropharynx, better known as the oral cavity, also helps to warm inhaled air. The laryngopharynx lies below and behind the larynx and extends to the esophagus.
You are called to the scene of an accident, where you find a middle-aged ice climber who is unresponsive to painful stimuli and has shallow respirations. He reportedly fell approximately 20 feet, striking his head and neck on a rocky outcrop. You note minor bleeding coming from the patient’s mouth as well as a deep cut on his chin. His pulse is rapid at 108/minute. The climber’s head and neck appear “crooked,” and his left arm appears bent at an unnatural angle.

What should you do?

The epiglottis is a leaflike structure that directs air into the trachea and lungs and prevents food or liquids from entering the lower airway. Below the epiglottis is the larynx, or voice box, where sound originates when we speak.

The lower airway includes the trachea, bronchi, and alveoli (Figure 9-3). The trachea is a tube, made in part of cartilage that ends at the two main stem bronchi, each of which extends into one lung. These bronchi continue as smaller bronchi,

Figure 9-2 Anatomy of the upper airway.
eventually branching into many smaller bronchioles and end in the alveoli, where gases are exchanged in the lung. For more information about the airway, review the appropriate section in Chapter 6 on Anatomy and Physiology.

Respiration, or breathing, is a biological process in which air enters the body and then is expelled back into the environment. Oxygen in the air enters the lungs, and carbon dioxide, a waste product, leaves the lungs. The conduit through which gas enters and exits the lungs is the airway. Breathing is a mechanical process, both active and passive in nature, consisting of two phases: inhalation and exhalation. Both phases are controlled by the nervous system and occur automatically.

Inhalation, also known as inspiration, is an active process during which the respiratory muscles contract, creating negative internal pressure in the chest cavity thereby causing air to flow inward. Exhalation, or expiration, is the passive phase of respiration. During this phase, the respiratory muscles relax, decreasing pressure within the chest, thereby expelling any unused air and gaseous waste products from the lungs and out of the body. For more detailed information about the mechanics of breathing, refer again to Chapter 6.

If breathing is compromised and oxygen cannot get into the blood through the lungs, respiratory distress is observed. Respiratory failure follows if this situation is not quickly corrected.

Airway Management

Airway management is the physical process that ensures the airway is open and clear. When the airway is closed, respiration cannot occur. The airway must be immediately opened to prevent injury or death. Numerous methods and tools are used to manage a partially or completely occluded airway. By learn-

**Figure 9-3** Anatomy of the lower airway.

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**STOP, THINK, UNDERSTAND**

**Multiple Choice**

Choose the correct answer.

1. The purpose of the nasopharynx is to ________
   a. prevent food from entering the trachea.
   b. remove noxious gases from inhaled air.
   c. warm and humidify air as it enters the body and to remove small particles.
   d. prevent air from entering the stomach.

2. The purpose of the larynx is to ________
   a. generate sound when we speak.
   b. warm and humidify air as it enters the body.
   c. prevent food from entering the trachea.
   d. prevent air from entering the esophagus.

3. Which of the following is not true regarding inhalation?
   a. It is controlled by the nervous system and occurs automatically.
   b. It is an active process during which respiratory muscles contract.
   c. Positive internal pressure in the chest cavity permits air to flow inward.
   d. All of the above are correct.

4. Which of the following is not true about expiration?
   a. It is controlled by the nervous system and occurs automatically.
   b. It is the active phase of respiration.
   c. During this phase the respiratory muscles relax, increasing air pressure within the chest and causing unused gaseous waste products to be removed (exhaled) from the lungs.
   d. All of the above are true.
Opening the Airway and Mouth

Normal breathing requires that the airway be intact, open and clear. In addition, the structures that constitute the upper airway must be properly aligned to allow the free flow of air into and out of the lungs. In an unresponsive patient, the airway muscles may relax, and in certain body positions this may cause the tongue to fall back and occlude the airway (Figure 9-4). When a patient’s head is unnaturally flexed, hyperextended, or tilted acutely to one side, the airway may become compressed or blocked. The first step in effective airway management is to ensure that the airway is open and aligned. The two primary methods used by OEC Technicians to align and open a patient’s airway are the head tilt-chin lift and the jaw-thrust maneuvers.

Head Tilt-Chin Lift

The head tilt-chin lift method is the primary technique OEC Technicians use to open a patient’s airway. Because this procedure manipulates the neck, it should be used only on patients who have no possibility of head, neck, or spine trauma. To perform the head tilt-chin lift procedure, take the following steps (Figures 9-5a–d):

1. Kneel beside the patient’s head.
2. Place one hand on the patient’s forehead.
3. Place two or three fingers of your other hand under the patient’s chin.
4. Gently pull the chin up while simultaneously pushing down on the forehead. Do not compress the soft tissue under the chin.
5. Maintain the position to ensure that the airway remains open.

Jaw-Thrust

If the patient has sustained head, neck, or spine trauma or there is even a concern about a potential cervical spine injury, open the airway using the jaw-thrust maneuver (Figure 9-6). This method opens the airway while allowing only minimal movement of the cervical spine. When performing a jaw thrust, it is essential that the neck

**Figure 9-4** An unresponsive person may experience breathing difficulties.

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Figure 9-5a  Anatomy of the adult in a neutral position.

Figure 9-5b  The head tilt-chin lift position; note the open airway.

Figure 9-5c  The neutral starting position for the head tilt-chin lift maneuver in an adult.

Figure 9-5d  The final tilted position of the head tilt-chin lift in an adult.

Figure 9-6  The jaw-thrust maneuver is used to open the airway in patients with a suspected spinal injury.
is not moved and remains in an anatomically neutral position, because any neck movement could result in spinal injury. To perform the jaw-thrust maneuver, take the following steps:

1. Kneel down above the patient’s head, with your knees straddling the head. (You can use your knees to gently stabilize the head and cervical spine.)
2. Using the fingers of both hands, grasp the angle of the mandible on each side of the jaw.
3. Place your thumbs on the maxilla.
4. Use the thumbs as a lever to lift the mandible upward.

Opening the Mouth Using the Crossed-Finger Method
If you need to open a patient’s mouth—to suction the oropharynx, to perform a finger sweep, or to insert an oral airway—the method most commonly used is the crossed-finger technique (Figure 9-7). Always use Standard Precautions. To open the patient’s mouth using this technique:

1. Using your dominant hand, cross your index finger under your thumb.
2. Place your thumb and index finger against the patient’s upper and lower teeth. (Be careful not to insert either finger between the patient’s teeth.)
3. Spread your thumb and finger apart to open the patient’s mouth.

Clearing the Airway
Effective breathing is difficult when any foreign material obstructs the airway. The airway-opening techniques just described keep the tongue from blocking the airway, but they are not effective in clearing other obstructions such as blood, mucus, fluids, broken teeth, foreign bodies, dirt, and food. Debris must be cleared quickly to ensure adequate oxygen flow and prevent aspiration of fluid or solids into the lungs. OEC Technicians can remove mechanical obstructions from the airway by three means: using gravity, a finger sweep, or suction.

Gravity
Gravity is a time-honored method for quickly removing fluid and solids from the airway, and it requires no special equipment. This technique can be effective regardless of whether the patient is responsive or unresponsive. If the patient is responsive and is able to follow simple commands, instruct the person to lean forward with the head down (in a dependent position) to allow vomit, blood, and any solids to flow or fall out of the mouth or nose. If the patient is unresponsive, roll the person into the recovery position (discussed shortly). In the presence of a suspected spinal injury, the patient may be rolled onto his side while another rescuer maintains the patient’s head and neck in a neutral position.

Finger Sweep
Occasionally, vomit, unchewed food, or other objects can become trapped in the airway; if not removed, the airway can become obstructed. If gravity is not effective in removing these objects, it may be necessary to clear the airway using the finger sweep technique (Figure 9-8). This technique is indicated only for patients...
who are unresponsive, because placing a finger into the airway of a person who is responsive could stimulate the gag reflex and induce even more vomiting, or it could cause the person to bite down, which could result in serious injury to the rescuer’s finger. Do not do a “blind finger sweep” by inserting your finger further than you can see, as this might further compromise the patient’s airway by pushing the object farther. To perform a finger sweep on an unresponsive patient, use the following steps:

1. Observing all Standard Precautions, open the patient’s mouth using the crossed-finger technique.
2. Insert your gloved index finger into the patient’s mouth such that the tip of your finger is behind or beneath the foreign object. (Be careful not to push the foreign object farther into the airway.)
3. Curve your finger into a hook and remove the object. (You may need to repeat this technique more than once to completely clear the airway.)

Suction
Another common method for clearing the airway is suctioning, which involves the use of negative air pressure to create a vacuum that is used to remove a liquid or solid. This procedure is very effective and is indicated any time the airway is compromised by fluid or particulate matter. Suctioning can be life saving and is especially crucial whenever repeated vomiting or active oral bleeding occurs.

OEC Technicians should be familiar with two basic types of suction devices: manually operated devices and powered devices. Portable devices are used primarily in the field, whereas fixed devices are generally used in an aid station, an ambulance, or a hospital. Become familiar with all the types of suction devices available to you, because suctioning is a life-saving skill that must be performed quickly and appropriately whenever the need arises.

Manually operated suction devices are lightweight, compact, and can provide adequate suction for short periods of time (Figure 9-9). They require a continuous pumping action by the rescuer, who serves as the power source. These devices usually have a small container for collecting fluids and debris. The container fills quickly, so these devices may not be adequate during prolonged rescue operations.

Powered suction devices provide excellent suctioning capabilities (Figure 9-10). Some are powered by an electric motor using AC current while others operate off a vacuum source from a vehicle engine (ambulance). Portable motorized units use rechargeable batteries. These devices are usually very reliable and provide consider-
able suction for extended periods of time. However, because they can be heavy, they may not be ideal for all circumstances (e.g., a ski patrol backpack). Regardless of whether it is hand operated or powered, all suction devices must be capable of generating a strong vacuum.

Suctioning is performed using either a rigid or a flexible catheter. A rigid suction catheter, also known as a “tonsil tip” or “Yankauer” catheter, is made from clear plastic and is curved or angled. Ideally, it should have a port (hole) in the handle that enables the OEC Technician to control the flow of suction. When the hole is covered with the thumb, suction is applied. Conversely, little or no suction occurs when the hole is left uncovered. On one end the catheter has a connector to which suction tubing is attached. The other end of the catheter has one or more holes through which fluid and solid matter are removed. Rigid suction catheters are primarily used to suction the oropharynx but also can be used to suction around the external nares.

A flexible suction catheter is a soft tube constructed of clear silicone or plastic. Its pliable design allows it to enter narrow passageways. For this reason, it is used to suction the nasopharynx, but it also may be used for oropharyngeal suctioning. As with a rigid catheter, a flexible suction catheter has an adapter on one end that connects to a suction tube; the other end is open.

Of the two types, rigid suction catheters are used more often by OEC Technicians because they are less affected by temperature and other environmental conditions and can remove large volumes of debris rapidly. ALS personnel use sterile soft catheters for deep suctioning of the lower airways. Both types of suction catheters are connected to a collection container through a clear, flexible suction tube. Manually powered suction devices usually have an integrated suction catheter that is directly connected to a disposable collection container, which is replaced following use.

Principles of Suctioning

If possible, “pre-oxygenate” the patient before suctioning by giving high-flow oxygen by mask to saturate the blood. Once you have prepared the suctioning device for use, open the patient’s mouth and then look into the oral pharynx to locate the fluid or object you need to remove. Insert the tip of the suction catheter into the pharynx before applying suction (Figure 9-11). Be careful not to insert the catheter farther than you can see because this may result in trauma to the soft oral tissues, initiate the gag reflex in a responsive or semi-responsive patient, or force a foreign body farther into the airway. To initiate suction, turn the machine on or cover the suction hole on the catheter. Suction only as deep as you can see to prevent pushing foreign matter farther into the airway. Using either a side-to-side or circular motion, suction the airway as you slowly withdraw the catheter from the airway. Remember to always protect the c-spine if you suspect any spinal trauma.

Apply suction for no more than 10–15 seconds at a time because the procedure does not remove fluid and debris only; it also removes oxygen, which could cause the patient’s condition to worsen. In a child, suction the airway for only 5–10 seconds. Repeat the procedure as needed until the airway is clear. When active oral bleeding or repeated vomiting is involved, it may be necessary to use gravity and suction concurrently to clear the airway. Report to ambulance personnel what material you suctioned out, especially if it included blood.

After each incident, the suction unit must be thoroughly cleaned and disinfected before being placed back into service. Additionally, all disposable equipment, such as the suction catheter, suction tubing, and collection bag, must be replaced. If the device is battery
operated, replace or recharge the batteries as necessary to ensure satisfactory performance when the device is next used. If the suction unit is manually powered, replace the catheter-collection assembly. Always put disposable medical equipment in a biohazard container to dispose of it properly. See OEC Skill 9-1.

**Keeping the Airway Open and Clear**

### Recovery Position

Once the airway is opened and cleared, it must remain in this state to ensure adequate breathing. The easiest method to achieve this, until other airway equipment or rescue personnel are available, is to place the patient into the HAINES (High Arm In Endangered Spine) recovery position (Figure 9-12). This position, also known as the coma or left lateral recumbent position, is indicated for any unresponsive patient in whom spine injury is not suspected. It also may be used for responsive patients and any patients with an altered level of responsiveness who cannot manage their airway. When alone, rescuers should use this technique to allow them to do other care-related tasks. To place a patient into the recovery position, perform the following procedure:

1. Kneel by the left side of the patient, preferably with your knees near the patient’s hips or chest.
2. Extend the patient’s left arm so that it extends over the person’s head.
3. Gently roll the patient toward you onto his left side so that his head rests on his straightened arm.
4. The head should be tilted at a slight downward angle, with the mouth open, to allow secretions to flow out of the mouth.
5. Flex the patient’s right knee at a right angle to anchor the patient into this position.
6. Position the patient’s right arm so that it is in front of the patient and does not block the rescuer’s access to the patient’s airway.
7. Always make sure the airway remains open.

### Airway Adjuncts

Sometimes it is necessary to insert an airway adjunct in order to keep the airway open. The OEC Technician has two options—a nasopharyngeal airway or an oropharyngeal airway (Table 9-1). One of these devices may be used depending on the patient’s level of responsiveness.

**Nasopharyngeal Airway** A nasopharyngeal airway (NPA) is a flexible tube that is inserted into the nasopharynx (Figure 9-13). It is made of soft, latex-free plastic. Also

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**Figure 9-12** The recovery position (or left lateral recumbent position) may be used to prevent aspiration in patients not suspected to have spinal injuries.

**Table 9-1** A Comparison of Oropharyngeal and Nasopharyngeal Airway Adjuncts

<table>
<thead>
<tr>
<th>Oropharyngeal Airway (OPA)</th>
<th>Nasopharyngeal Airway (NPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relieves airway obstruction caused by tongue</td>
<td>Relieves airway obstruction caused by the tongue or by mucus and nasal swelling</td>
</tr>
<tr>
<td>Relatively easy to insert</td>
<td>Easy to insert</td>
</tr>
<tr>
<td>Must not be used in a responsive patient or a person with an intact gag reflex</td>
<td>Can be safely used in responsive and semi-responsive patients or in a person with an intact gag reflex</td>
</tr>
<tr>
<td>Can be placed in patients who have nasal trauma</td>
<td>Caution required if used in patients who have oral trauma</td>
</tr>
</tbody>
</table>
CHAPTER 9
AIRWAY MANAGEMENT

Multiple Choice
Choose the correct answer.

1. Which of the following is not true about airway management?
   a. It is a physical process that ensures that the airway is open and clear.
   b. Respiration cannot occur through a closed or blocked (occluded) airway.
   c. It is a fundamental and crucial life-saving skill that OEC Technicians must learn.
   d. True airway maintenance is beyond the scope of OEC Technicians.

2. Which of the following is a method for opening the airway?
   a. Head tilt-chin lift maneuver
   b. Crossed-finger maneuver
   c. Jaw-thrust maneuver
   d. Both A and C

3. Which of the following is not correct regarding suctioning of an airway?
   a. Insert the catheter into the airway with the suction on (thumb hole covered).
   b. Insert the catheter only as deeply as you can see.
   c. Suction side to side for 10–15 seconds maximum in an adult, for 5–10 seconds maximum in a child.
   d. Insert the catheter tip into the airway with the suction off (thumb hole open).
   e. Suction only the outer nares and lips, allowing gravity to clear the remainder of the oropharynx and nasopharynx.
   f. Suctioning is not a skill that OEC Technicians may perform.

4. What can cause an airway to occlude and prevent adequate breathing? (check all that apply)
   a. _______ The tongue falling back into the pharynx
   b. _______ Unnatural flexion, extension, or tilting of the patient’s head
   c. _______ An inhaled foreign object such as food or a small toy
   d. _______ Blood or vomitus
   e. _______ Broken teeth

5. Which of the following methods may be used to remove fluid and solids (such as vomitus or broken teeth) from a responsive patient’s mouth? (check all that apply)
   a. _______ Placing the patient sitting forward with the head in a dependent position
   b. _______ Placing the patient in the recovery position with or without spinal precautions, as indicated
   c. _______ Using suction with a rigid or flexible catheter

6. Which of the following methods may be used to remove fluids or solids from an unresponsive patient’s mouth? (check all that apply)
   a. _______ Using a finger sweep
   b. _______ Placing the patient in the recovery position with or without spinal precautions, as indicated
   c. _______ Using suction with a rigid or flexible catheter

known as a nasal trumpet, this mechanical airway provides an unobstructed pathway from an external nares to the posterior nasopharynx, keeping the passageway open for air exchange. When properly sized, the adjunct is well tolerated, even in responsive patients, as it does not stimulate the gag reflex. NPAs come in a variety of sizes and can be used in all patients, from small children to large adults.

The indications for an NPA are fairly broad and include any patient in whom a mechanical airway is needed to keep the airway open. Indications include patients who

- are unresponsive or semi-responsive,
- have altered mental status and an intact gag reflex,
- exhibit signs of partial airway obstruction (as when snoring),
- have oral injuries and airway compromise, or
- have had, or are having, a seizure and whose teeth are tightly clenched.

The adjunct is relatively contraindicated in patients with massive head injuries due to possible aggravation of the injury and/or damage to the nose.

Proper insertion of an NPA consists of the following four steps, which can be remembered using the acronym “SLIC” (OEC Skill 9-2[n]).
S—Size the adjunct. NPAs come in a variety of sizes. To be effective, the device must be sized appropriately. A tube that is too small may become blocked by the tongue, whereas a tube that is too large may enter the esophagus or stimulate the patient’s gag reflex. To properly size an NPA, hold the tube against the side of the patient’s face. For a tube that is the correct size, the flange should rest against the nostril, the end should just touch the patient’s lower earlobe on the same side of the face, and the outside of the tube should be slightly smaller than the nostril into which it will be placed.

L—Lubricate the adjunct. Apply a small amount of water-based lubricant along the entire length of the NPA tube. Be careful not to apply too much lubricant, which could aggravate an existing airway problem. The goal is to provide a slippery surface so that the tube can slide gently into position.

I—Insert the adjunct. To insert an NPA:
- Hold the tube between your thumb and first two fingers.
- Place the bevel side of the tube toward the nasal septum.
- Gently insert the tube into the nostril while rotating the tube between your fingers until the flange is flush with the nostril. Do not force the tube into position because that can cause a nosebleed, an obstruction, or other injuries. If you meet an obstruction, pull the tube back slightly and reinsert, again while rotating the tube between your fingers. Properly placed, the curvature of the tube will follow the natural curve of the nasal passage and lie in the distal portion of the nasopharynx directly above the larynx.

C—Check the adjunct. Confirm proper placement of the tube by listening to the patient breathe. You should be able to hear or feel air movement through the tube. If no air is detected, check to see if the patient is still breathing. If the patient is not, assist the patient’s ventilations. If the patient is breathing, the tube may be obstructed, may need to be repositioned, or may need to be removed and resized. Rarely, foreign material inside the nose can obstruct the opening of the NPA.

If the patient’s level of responsiveness improves, you may need to remove the NPA. To accomplish this, simply grasp the NPA by the flange and withdraw the adjunct using a steady downward motion that follows the device’s curvature.

Oropharyngeal Airway

An oropharyngeal airway (OPA) is a hard plastic device that is inserted into the oropharynx to help keep the airway open (Figure 9-14). The device displaces the relaxed tongue and prevents it from lying across the epiglottis and occluding the airway. When the OPA is in place, the tongue rests within the curvature of the device. An OPA is indicated only for patients who do not have a gag reflex and are unable to protect the airway. The device is frequently used when assisting ventilations with a bag valve mask.

If you attempt to place an oropharyngeal airway into a patient who is either fully or partially responsive, it will stimulate the gag reflex, which may result in vomiting and possible aspiration of gastric contents. If when the soft palate is touched by the OPA and the person gags, remove the OPA and do not reinsert it.

Proper insertion of an OPA consists of the following three steps, which may be remembered using the mnemonic “SIC” (OEC Skill 9-3).

S—Size the adjunct. OPAs come in several sizes ranging from #0 for infants to #6 for large adults. As with an NPA, an OPA must be properly sized to be effective. An OPA that is too small will force
the tongue downward and block the oropharynx, whereas an OPA that is too large can enter the esophagus or damage the epiglottis or vocal cords.

To properly size an OPA, hold the adjunct against the side of the patient’s face with the flange adjacent to the corner of the patient’s mouth. The tip of the adjunct should touch the angle of the jaw on the same side of the face; alternatively, measure from the corner of the mouth to the earlobe on the same side of the face.

I—Insert the adjunct. To insert an OPA, open the patient’s mouth using the crossed-finger technique. Insert the OPA, with the tip pointed up toward the roof of the mouth, until it is halfway into the mouth. Then rotate the adjunct 180 degrees such that the tip faces toward the patient’s tongue. The tongue should now lie along the curve of the OPA, and the external flange should rest against the patient’s lips.

An alternative method for placing an OPA involves the use of a tongue blade, bite block (device used to hold mouth open and prevent the patient from biting his tongue or the oral airway), or other smooth object. Using a tongue blade, depress the tongue toward the floor of the mouth. Then, insert the adjunct along the side of the mouth, with the tip pointing toward the inside cheek, until the OPA is halfway into the mouth. Rotate the OPA 90 degrees until the flange rests on the patient’s lips.

C—Check the adjunct. Confirm proper placement by listening for breaths, watching the chest rise and fall, and feeling air moving in and out of the OPA. If the adjunct is properly placed, air should be able to move freely in and out of the airway (either spontaneously, or when using a ventilation assistance device such as a pocket mask or bag-valve mask). If air does not move freely, the tongue may have been pushed farther back into the posterior pharynx and may be blocking the airway. As before, remove the OPA, confirm that it is properly sized, and then reinset it.

Multiple Choice

Choose the correct answer.

1. The mnemonic SLIC stands for __________
   a. size, length, intubate, compress.
   b. suction, lubrication, insertion, compression.
   c. suction, lubrication, insertion, control.
   d. size, lubricate, insert, check.

2. Write either “NPA” or “OPA” in the blanks to correctly categorize the following descriptions.
   a. __________ Indicated for use only in patients without a gag reflex
   b. __________ For use in unresponsive patients only
   c. __________ Can be used on a seizing patient with clenched teeth
   d. __________ A soft, flexible device
   e. __________ Contraindicated in patients with massive head trauma
   f. __________ A rigid, hard, plastic device
   g. __________ Works by displacing the tongue
   h. __________ Is tolerated by responsive patients
   i. __________ Can be used on a patient with signs/symptoms of partial airway obstruction such as snoring
   j. __________ Also known as a “nasal trumpet”
   k. __________ Provides an unobstructed path from the external nare to the posterior pharynx

Short Answer

1. You have inserted an OPA into an unresponsive patient. Under what two conditions could it be removed?
An OPA should be left in place until one of two conditions arises: either the patient begins to gag, or a more-advanced airway adjunct (Chapter 36) is inserted by an ALS provider. However, in the event that you need to remove an OPA, grasp the adjunct by the flanges and pull it both outward and slightly downward, following the natural contour of the tongue. Removal should be performed in one swift motion to reduce the incidence of vomiting and other complications. Have a suction device ready in case the patient vomits.

**Barrier Devices**

OEC Technicians are sometimes the first rescuers to arrive at an incident, but they may not always have immediate access to certain medical equipment. Accordingly, be prepared for such contingencies by always carrying a few key items—including disposable medical gloves and a barrier device in the event you need to provide rescue breaths (Appendix A: Survival Kit).

Barrier devices are a form of personal protective equipment that provides a non-porous layer between you and the patient to prevent the transmission of communicable diseases (Figure 9-15). Used properly, a barrier device is an effective way to ventilate a patient until more sophisticated airway equipment and oxygen become available.

Barrier devices permit OEC Technicians to provide rescue breaths using the residual oxygen in the rescuer’s lungs. The mixture of gases in exhaled air contains approximately 15–16 percent oxygen, which is enough to provide effective oxygenation to a patient who is not breathing. Room air is 21 percent oxygen. The use of a barrier device will help to ensure BSI precautions are maintained. The most common barrier devices used for this purpose are a face shield and a pocket mask.

**Face Shield**

A face shield is a clear plastic sheet, usually rectangular in shape, with a mouthpiece through which to administer rescue breaths. Some face shields also have an integrated one-way valve/bite block that directs air flow into the patient’s airway while preventing the rescuer from becoming contaminated. To use a face shield, perform the following procedure:

1. Kneel at either side of the patient’s head.
2. Remove the face shield from its protective package and place the shield over the patient’s mouth and nose. If the device contains an integrated one-way valve/bite-block, place the valve into the patient’s mouth, between the teeth.
3. Pinch the patient’s nose and seal your lips on the shield around the valve (as if you were performing normal mouth-to-mouth resuscitation) and provide rescue breaths. You should see the chest rise and fall with each breath.

**Pocket Mask**  
A **pocket mask** is a triangular or pear-shaped barrier device made from clear, soft plastic or silicone (Figure 9-16). Some older styles are circular or donut shaped. The apex of the mask fits over the bridge of the patient’s nose. Some pocket masks include a built-in oxygen port that allows the device to be connected to supplemental oxygen. Used correctly, a pocket mask provides an excellent seal on the patient’s face and offers better protection from blood and secretions than a face shield.

A pocket mask generally consists of three parts: a mask, a one-way valve, and a breathing tube. To assemble a pocket mask, follow this procedure:

1. Remove the device from its protective package or case.  
2. Open the mask (by pulling on the connector, if necessary).  
3. Connect the one-way valve to the mask. (Follow the manufacturer’s instructions to ensure that the valve is pointed toward the patient.)  
4. Connect the breathing tube to the one-way valve.

To deliver rescue breaths using a pocket mask, follow these steps (Figures 9-17a and 9-17b):

1. Assemble the pocket mask as previously described.  
2. Kneel at the top of the patient’s head, and open the airway using either the head tilt-chin lift or the jaw-thrust maneuver.  
3. Fit the mask onto the patient, placing the apex of the triangle on the bridge of the patient’s nose. The mask should be rocked down so that the base of the triangle fits in the groove between the patient’s lower lip and chin. If the mask does not fit in the groove, the mask may not be the correct size, or it may need to be repositioned on the face.
4. Place your thumbs on the top of the mask, near the bridge of the patient’s nose, while simultaneously placing your index fingers on the bottom of the mask, which is over the section between the lower lip and chin.
5. Place the middle, ring, and little fingers of both your hands under the mandible and pull upward, toward the mask (as opposed to pushing the mask down onto the face).
6. Place your lips around the open port and deliver a rescue breath. You should see the patient’s chest rise and fall with each breath. If the patient’s chest does not rise or if you hear air escaping between the mask and the patient’s face, reposition the device and then deliver another rescue breath. If the chest still does not rise, follow obstructed airway procedures.

Creating an adequate seal and delivering appropriate rescue breaths with a pocket mask is one of the most important skills in emergency airway and respiration care. Practice this skill until you are very comfortable with it.

Oxygen Therapy

Oxygen, also known by its chemical symbol O₂, is an odorless, colorless, and tasteless gas that is essential to human survival. Ambient air consists of 78 percent nitrogen, 21 percent oxygen, and 1 percent other gases. The human body requires a constant supply of oxygen in order to function properly. If the body does not receive enough oxygen, cellular or tissue damage, organ failure, shock, or death can occur. Ensuring that a patient’s blood is sufficiently oxygenated may require you to administer supplemental oxygen.

Administering oxygen—or providing oxygen therapy—is an essential part of an OEC Technician’s training and treatment regimen. In some jurisdictions, OEC Technicians may administer oxygen as part of their regular care, whereas in others the administration of oxygen requires a physician order. Such an order may be provided by a patrol’s medical advisor as either an indirect or direct order, or it may be obtained through the local emergency care system’s medical command. It is best to develop a local protocol concerning oxygen delivery by incorporating input from a local doctor, management, and the patrol’s leadership. In some areas, OEC Technicians are not legally permitted to administer oxygen. To determine if you are permitted to provide oxygen therapy in your state, province, or area, check with your patrol director, area management, or state EMS office.

Oxygen Containers

Oxygen administered to patients is 100 percent pure oxygen. Unlike industrial oxygen, which should not be administered to patients, medical oxygen contains no impurities. Medical oxygen is stored as a compressed gas in specially marked cylinders that are either solid green or have a large green stripe on top (Figure 9-18). Most oxygen cylinders are constructed of lightweight aluminum, although older cylinders made from steel may still be encountered. Oxygen cylinders come in a variety of sizes (Table 9-2). Smaller cylinders, such as C, D, and E cylinders, are lightweight, making them easy to carry and store. When full, these cylinders contain 350 to 625 liters of oxygen. Small cylinders are designed for short-term use. Large oxygen cylinders, such as M, H, and K cylinders, are more cumber-
some but contain several thousand liters of oxygen. Because of their size and weight, large oxygen cylinders are usually found on ambulances, in hospitals, and in ski patrol first-aid rooms or base camps.

An oxygen cylinder consists of three components: a cylinder, a neck, and a valve stem:

- **Cylinder.** The cylinder serves as a reservoir in which highly compressed oxygen gas is stored. Depending on size, a full oxygen cylinder can hold between 350 and 6,900 liters of oxygen at a pressure of 2,000–2,200 pounds per square inch (psi).

- **Neck.** The neck of an oxygen cylinder extends outward from the cylinder and contains three holes—a large hole toward the top and two smaller holes located directly beneath (Figure 9-19). The location of these holes is universal to all medical oxygen cylinders and is part of the internal pin index system.

- **Valve stem.** The valve stem is a small protrusion that extends approximately 0.5–1 inch beyond the neck and is used to turn the cylinder on and off.

In order to safely administer oxygen to a patient, the gas must first be routed through a pressure regulator, which significantly reduces its pressure to approximately 40–70 psi. Each type of gas has a unique pressure regulator that conforms to the universal pin index system. This safety precaution ensures that the regulator will fit only the type of gas cylinder for which it is intended. As a result, only oxygen gas can be administered through an oxygen regulator.

Several different types of commercial oxygen regulators are available. Most small oxygen cylinders (e.g., D, E cylinders) utilize a yoke regulator assembly, whereas large cylinders typically have a screw-on regulator assembly (Figure 9-20). Yoke-type regulator assemblies usually have a large thumb screw for securing the regulator to the tank neck. The large hole inside the yoke assembly is surrounded by a dime-size plastic or silicone gasket, which prevents gas leaks. Oxygen regulators also have at least two gauges: a pressure gauge, which indicates the pressure in the tank, and a flow gauge, which indicates the number of liters of oxygen being administered per minute (LPM). A large knob enables you to control the rate of oxygen flow, which for most clinical applications is 2–15 LPM. A part of the regulator—a small graduated adapter known as a “Christmas tree”—connects to a tube that in turn connects to an oxygen delivery device.

### Oxygen Cylinder Set-Up and Breakdown

To set up an oxygen cylinder, you must first inspect the entire cylinder, including the gasket—an O-shaped plastic, silicone, or rubber disk that seals the regulator to the cylinder and helps prevent leaks. If the gasket is dry or cracked, replace it before continuing. Then, before attaching a regulator to a cylinder, “crack” the cylinder by opening the cylinder valve slightly for one second, and then close the valve. This clears the cylinder of any dirt or debris that has accumulated since the cylinder was used last.

### Table 9-2 Oxygen Cylinder Sizes and Volumes

<table>
<thead>
<tr>
<th>Size</th>
<th>Volume (Liters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>350</td>
</tr>
<tr>
<td>Super D</td>
<td>500</td>
</tr>
<tr>
<td>E</td>
<td>625</td>
</tr>
<tr>
<td>M</td>
<td>3,000</td>
</tr>
<tr>
<td>G</td>
<td>5,300</td>
</tr>
<tr>
<td>H, A, K</td>
<td>6,900</td>
</tr>
</tbody>
</table>
To prepare the oxygen cylinder and oxygen regulator, align the large circular fitting and the two smaller pins on the regulator with the corresponding circular hole and two smaller holes on the neck of the oxygen cylinder. The pins and holes should match perfectly. Finger-tighten the screw bolt or knob until the fittings and pins fit snugly together. Do not over-tighten the screw or knob, as this could damage the assembly or cylinder and can make removal of the regulator very difficult, especially in extreme temperatures (OEC Skill 9-4).

To open the oxygen system, turn the valve stem on the top of the cylinder counterclockwise, using a special oxygen wrench or key that should be stored with the cylinder. If you hear a hissing sound, the regulator is not seated correctly onto the cylinder. Turn off the oxygen flow, remove the regulator from the cylinder, check the gasket (replace if old, cracked, or dry), and reconnect the regulator. Check the pressure gauge indicator to determine the pressure in the cylinder. Check to make sure that the cylinder contains enough oxygen for its intended use—and make sure that it is not empty! If you will be performing an extended rescue or a medical operation, the cylinder should be full (approximately 2,000 psi). Oxygen cylinders should be refilled once they reach 500 psi or less.

To begin the flow of oxygen, turn the oxygen control knob counterclockwise. Use the oxygen flow gauge to set the amount of oxygen that you wish to administer. To stop the flow of oxygen, simply reverse the process by turning the oxygen flow knob clockwise until it stops. To turn the cylinder off, turn the valve stem clockwise until it stops, being careful not to over-tighten it. At this point, the cylinder is closed, and oxygen is no longer flowing into the regulator. However, there is still a small amount of oxygen trapped within the regulator that must be released; otherwise, it can damage the regulator. The process of relieving this residual pressure is known as “bleeding the cylinder” and is performed as follows:

1. With the cylinder turned off, turn the oxygen flow knob counter-clockwise (open) until you no longer hear gas escaping. Check the pressure gauge to ensure that the pressure is at 0 psi. (Again, be careful not to over-tighten the knob.)
2. Turn the oxygen flow knob clockwise (close) to close the system completely.

The oxygen delivery system is now completely turned off and drained and is ready to be used again or to be placed into storage until the next time it is needed. Oxygen equipment that will not be used again soon should be disassembled for storage. To remove the regulator from the cylinder, ensure that the cylinder is turned off, and that any remaining oxygen in the regulator has been bled. Turn the yoke screw counterclockwise, and remove the regulator from the cylinder.

### Oxygen Flow Duration Rates

As you will learn in future chapters, oxygen therapy is an essential part of the care regimen for numerous medical and trauma conditions. In many cases, oxygen is the primary care rendered and is delivered in a specific amount known as a “flow rate.” If you operate in an environment in which transport or extrication may be prolonged, you must carefully balance the flow rate you administer with the amount of oxygen available and the patient’s anticipated oxygen needs; in fact, it may become necessary to ration the amount of oxygen that is administered to extend the time it is available.

To calculate the duration of oxygen flow from a single cylinder, use the following equation:

\[
\text{Duration of flow} = \frac{(\text{Gauge pressure in psi} - \text{safe residual pressure}) \times \text{cylinder size constant}}{\text{Flow rate in LPM}}
\]
For most cylinders, the “safe residual pressure” is 200 psi; below this level, the oxygen pressure is dangerously low. For cylinder size constants, see Table 9-3.

Knowing how to calculate how long your oxygen supply will last at a given flow rate enables you to make good patient care decisions. For example, suppose you respond to an incident carrying a full D cylinder containing 2,000 psi. (This is the most common oxygen cylinder size available to OEC technicians and other rescuers.) If the oxygen flow rate is set at 4 LPM, for how long can you expect oxygen to continue flowing?

\[
\text{Duration of flow} = \frac{(2,000 - 200) \times 0.16}{4 \text{ LPM}} = 72 \text{ minutes}
\]

Thus, at 4 LPM, you can expect a maximum of 72 minutes of continuous oxygen flow.

Likewise, if the patient requires oxygen at 15 LPM, the same full cylinder will only last 19 minutes:

\[
\frac{(2,000 - 200) \times 0.16}{15 \text{ LPM}} = 19.2 \text{ minutes}
\]

As you can see from the latter example, when continuous oxygen therapy must be delivered in remote settings or during incidents when extrication or transport is prolonged, multiple oxygen cylinders may be needed.

**Oxygen Safety**

Oxygen cylinders are vessels containing highly compressed gas and should be treated very carefully to prevent inadvertent damage and injury. As a rule, they should be laid on their side, kept in a protective carrier, or firmly secured to a wall to prevent them from falling. Before each use, inspect the cylinder for damage, including dents or cracks in the valve-gauge assembly or the cylinder. Other safety tips include the following:

- Never use oxygen near a spark or flame such as candles, a camp fire, a stove, or a heater.
- Do not allow a patient or others to smoke when oxygen is being used.
- Keep oil, grease, or other petroleum-based or combustible materials away from oxygen cylinders and oxygen regulators.
- Turn the oxygen cylinder off when it is not in use.
- Protect the valve stem from damage.
- Leave protective caps in place until the cylinder is ready for use.
- Clear valve stems of dust and debris before attaching the regulator.
- Do not over-tighten the valve stem, saddle screw, or regulator knobs.
Indications for Oxygen Therapy

Oxygen should be administered to anyone who is short of breath. Patients with suspected cardiac or respiratory arrest, cardiac-related chest pain, stroke, significant blood loss, shock, decreased level of responsiveness, head injury, or a broken long bone should receive oxygen. By administering supplemental O₂, an OEC Technician increases the oxygen saturation of hemoglobin in the blood, providing more oxygen to the body’s tissues. If not enough O₂ is supplied to the body’s tissues, hypoxia results. Patients who have chronic lung disease (usually from smoking), those whose respiratory rate has been decreased by an overdose of depressant drugs, or those whose respiratory rate has been decreased by an overdose of depressant drugs, or those who have a

Multiple Choice

Choose the correct answer.

1. What is the chemical symbol for oxygen? ____________
   a. O₂
e. Ox₂
c. O₃
b. CO₂
d. Measured in psi.

2. Ambient air consists of ____________
   a. 21% nitrogen, 78% oxygen, and 1% carbon dioxide.
   b. 50% oxygen, 50% nitrogen, and a trace of other gases.
   c. 78% nitrogen, 21% oxygen, and 1% other gases.
   d. 100% oxygen.

3. Which of the following statements about oxygen administration best describes an OEC Technician’s role in its use? ____________
   a. All OEC Technicians may administer oxygen.
   b. Oxygen administration is a skill in which OEC Technicians may assist a higher-level caregiver, but OEC Technicians may not administer oxygen themselves.
   c. Only paramedics and physicians may administer oxygen.
   d. The legality of oxygen administration by OEC Technicians varies from state to state and county to county; it is the responsibility of each OEC Technician to determine what local protocol is.

4. Which of the following statements is true? ____________
   a. Medical oxygen cylinders contain 78% oxygen, 21% nitrogen, and 1% inert gases.
   b. Medical oxygen and industrial oxygen may be used interchangeably as long as a filter is applied to the regulator.
   c. Medical oxygen cylinders are green and contain 100 percent oxygen.
   d. On a low-flow setting, a small (C, D, or E) cylinder contains enough oxygen for use during a lengthy transport, because these cylinders are compact, lightweight, and efficient.

5. The abbreviations psi and LPM stand for ____________
   a. pin securing index and last pressure measurement.
   b. portable site indicator and load per millimeter.
   c. pound at site inertia and liter pinto metric.
   d. pounds per square inch and liters per minute.

6. The usual flow rate for the clinical administration of oxygen is ____________
   a. 2–15 LPM.
   b. 1–10 LPM.
   c. 5–30 LPM.
   d. measured in psi.

7. The purpose of “cracking” a cylinder before use is ____________
   a. to ensure that the cylinder is full.
   b. to bleed off enough pressure to lessen the chance of damaging the regulator.
   c. to clear the cylinder of dirt or debris before attaching the regulator.
   d. one should never “crack” an oxygen cylinder.

8. Upon attaching a regulator set at 0 LPM and opening the valve stem, you hear a loud hissing sound. This is indicative of what? ____________
   a. The regulator is not sealed correctly onto the cylinder.
   b. The regulator is properly attached and O₂ is flowing properly.
   c. The cylinder is almost empty.
   d. The cylinder has been overfilled and should be bled before use.

9. At what level should an oxygen cylinder be refilled? ____________
   a. 1,000 psi.
   b. 500 psi.
   c. 200 psi.
   d. Only when it is completely empty.

10. What is the purpose of bleeding residual air out of the regulator after use? ____________
    a. It completely empties the cylinder of the final 200 psi so it can be safely refilled.
    b. It removes debris in the regulator neck.
    c. It fills the regulator with 25 psi so that it is ready for use on the next patient.
    d. It removes air trapped within the regulator and prevents regulator damage.

11. It is appropriate to give oxygen to which of the following patients? (check all that apply)
    a. ____________A patient who is in respiratory or cardiac arrest
    b. ____________Any patient who is short of breath (SOB)
    c. ____________A patient with a decreased or deteriorating level of responsiveness
    d. ____________A patient who has suffered a severe blood loss
    e. ____________A patient with multiple fractures
    f. ____________A patient who is sweating, anxious, and complaining of chest pain
failing heart may be hypoxic and need oxygen. These signs and symptoms, and the conditions with which they are associated, are covered in other chapters.

**Oxygen Delivery/Ventilation Adjuncts**

A number of different adjuncts are available for delivering oxygen to a patient or for assisting ventilations. The method of delivery you choose must be tailored to meet the patient’s needs, and OEC Technicians must be very familiar with the indications, set-up, and use of each airway delivery adjunct. OEC Technicians may use the following oxygen-delivery devices:

- Nasal cannula
- Nonrebreather mask
- Bag-valve mask

**Nasal Cannula**

A nasal cannula (NC) is a flexible, circular tube that is attached to a long clear hose (Figure 9-21). It has two short, pliable hollow prongs for passively delivering small amounts of oxygen, or “low-flow” oxygen, into the patient’s nostrils. When the two short prongs are inserted (concave down) into the patient’s nostrils, the nasopharynx is filled with oxygen-enriched air that is then inhaled into the lungs. The range of flow rates of a nasal cannula is 1–6 LPM, with 2–4 LPM being the typical initial rate of administration (Table 9-4). This delivers an oxygen concentration of 24–44 percent. The actual percentage of oxygen varies according to whether the patient breathes exclusively through the nose or also through the mouth. A nasal cannula is quite comfortable and is usually well tolerated.

Patients often prefer a nasal cannula over oxygen-delivery masks because it is less restrictive and because not covering the nose and mouth provokes less anxiety.

Nasal cannulas do have several drawbacks. Prolonged use is associated with drying of the nasal passages. In addition, at low rates (1–3 LPM) the delivery of oxygen is minimal. Thus, this adjunct is not recommended for use on patients who require high concentrations of oxygen, such as those who exhibit signs of respiratory distress or shock or have severe chest pain. However, for patients who refuse to wear a mask that delivers a higher concentration of O₂, the use of a nasal cannula at 2–4 LPM is better than providing no supplemental oxygen at all.

To apply a nasal cannula, attach the connector at the end of the connecting tubing to the Christmas tree on the regulator. Set the oxygen regulator to the desired flow rate in LPM. Slide the lariat lock (a slide lock found on the nasal cannula tubing that is adjustable and holds the cannula in place on the patient’s face) to its full open position, and

![Figure 9-21 A nasal cannula.](image)

**Table 9-4** Data on Oxygen Delivery Through a Nasal Cannula

<table>
<thead>
<tr>
<th>Flow Rate</th>
<th>Percentage of Oxygen Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 LPM</td>
<td>24%</td>
</tr>
<tr>
<td>2 LPM</td>
<td>28%</td>
</tr>
<tr>
<td>3 LPM</td>
<td>32%</td>
</tr>
<tr>
<td>4 LPM</td>
<td>36%</td>
</tr>
<tr>
<td>5 LPM</td>
<td>40%</td>
</tr>
<tr>
<td>6 LPM</td>
<td>44%</td>
</tr>
</tbody>
</table>
place the two prongs into the patient's nostrils while looping the cannula tubing over each ear. Slide the lariat lock up so that it holds the cannula in place. Check with the patient to ensure the lariat lock is not too tight and that the device is comfortable. Do not place the cannula completely over the patient's head because this is both uncomfortable and could put the patient in danger should a portion of the loose hose become snagged on an obstacle such as a tree branch or rock. If the patient tends to breathe through the mouth, you may place the two prongs at the entrance to the patient's mouth.

**Nonrebreather Mask**

A nonrebreather mask (NRB) is a clear plastic mask that covers both the nose and mouth and has a bag (the reservoir) that hangs beneath the mask (Figure 9-22). This bag is connected to connecting tubing that continually fills the reservoir with oxygen. Each time the patient takes a breath, oxygen within the reservoir is drawn into the mask and inhaled into the lungs. During exhalations, the flap valve on top of the reservoir closes while the flap valve(s) on each side of the mask open while the reservoir refills with oxygen. Thus, the patient cannot “rebreathe” expired gases and breathes only oxygen during inhalation.

As a result of this design, a nonrebreather mask can deliver 80–90 percent oxygen to the patient and has a flow rate of 10–15 LPM. The actual amount of oxygen delivered depends on the flow rate and the face seal (Table 9-5).

A nonrebreather mask is the most common oxygen delivery device used by OEC Technicians and is appropriate for patients who have serious respiratory, cardiac, or trauma-related problems. The main disadvantage of a nonrebreather mask is that the mask covers both the nose and the mouth, which can cause the patient anxiety. Communication with the patient can also be difficult due to the mask's position over the mouth and the noise of oxygen flow, especially at higher flow rates. Reassurance and calming techniques frequently relieve the patient's anxiety greatly.

To prepare an NRB for use, remove the mask from its protective wrapper and connect the attached connecting tubing to the regulator. Set the regulator at the desired flow rate, usually 12–15 LPM while simultaneously holding down the flap valve lor-
cated inside the nose piece of the mask until the reservoir completely inflates. Next, place the mask on the patient’s face, placing the elastic strap behind the patient’s head to help hold the mask in place. Once the mask is properly positioned on the patient’s face, gently squeeze the aluminum nose piece to help ensure a good seal. Then, observe while the patient breathes. Upon each inspiration, the reservoir bag should deflate by about two-thirds of its total volume.

To conserve oxygen, such as might be required during a prolonged rescue operation, decrease the flow rate. However, do not lower the oxygen flow rate to the point at which the reservoir becomes completely empty between breaths. Adjust the oxygen flow to a level that nearly, but not completely, allows the bag to fully collapse when the patient inhales.

Bag-Valve Mask

Bag-valve mask (BVM) is the device that OEC Technicians use most widely for ventilating patients who are not breathing, need assisted ventilation, or are critically ill or injured. The system typically consists of an oxygen reservoir, a football–size self-expanding bag, a one-way valve, a universal adaptor, and a clear flexible mask (Figure 9-23a). The BVM is typically constructed from silicone, whereas the reservoir and universal adapter are generally fashioned from plastic. The unit should be latex free.

The system can deliver ambient air, or it may be connected to a supplemental oxygen supply. The flow rate for this device is 12–15 LPM, which delivers 80–100 percent oxygen, depending on the quality of the seal of the face mask. The volume delivered also can vary, depending on bag size and depth of ventilation (Table 9-6).

BVMs come in three basic sizes: adult, child, and infant (Figure 9-23b). When the appropriate size bag is used, the device should automatically deliver the correct

<table>
<thead>
<tr>
<th>Flow Rate</th>
<th>Percentage of Oxygen Delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 LPM</td>
<td>80%</td>
</tr>
<tr>
<td>11 LPM</td>
<td>82%</td>
</tr>
<tr>
<td>12 LPM</td>
<td>84%</td>
</tr>
<tr>
<td>13 LPM</td>
<td>86%</td>
</tr>
<tr>
<td>14 LPM</td>
<td>88%</td>
</tr>
<tr>
<td>15 LPM</td>
<td>90%</td>
</tr>
</tbody>
</table>

**Table 9-6** Bag-Valve Mask Ventilation Volumes

<table>
<thead>
<tr>
<th>Size</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>1,200–1,600 mL</td>
</tr>
<tr>
<td>Pediatric</td>
<td>500–700 mL</td>
</tr>
<tr>
<td>Infant</td>
<td>150–240 mL</td>
</tr>
</tbody>
</table>
volume of oxygen per breath. As noted previously, a BVM can be used with or without supplemental oxygen. When available, oxygen should be used. A BVM is ergonomically designed to enable a rescuer to ventilate and deliver large quantities of oxygen to a patient for an extended period of time.

In addition, the system is hand operated, resulting in greater safety for the patient and less fatigue for the operator compared to either a face shield or pocket mask. However, the BVM setup is larger than some of the other oxygen-delivery devices and is usually included as part of a large medical backpack, not in a small medical belt or pack.

A BVM can be used effectively by one or two rescuers. Two people are recommended because this provides the most effective method for obtaining a good seal and more effective ventilations. To use a BVM, it must first be assembled. Most rescuers store the self-expanding bag in its collapsed form, as this saves space in the rescue pack. Begin by pulling both ends of the bag outward to fully expand the bag. Connect the reservoir. Attach the oxygen tubing from the BVM to the oxygen regulator, and set the flow rate to 15 LPM. The reservoir should begin to fill immediately. Attach the universal, L-shaped adapter to the other end of the bag. Then, connect the face mask to the universal adapter. The system is now ready to use.

A properly sized oral or nasal airway should be inserted into the patient before using a BVM to help keep the airway open when assisting with ventilation.

**One-Rescuer BVM** The one-rescuer BVM technique should be used only when other rescuers are not available to assist (Figure 9-24). To perform one-rescuer BVM ventilations, follow these steps:

1. Kneel next to the top of the patient’s head.
2. Place the mask on the patient’s face with the apex (top) of the mask over the bridge of the patient’s nose. The mask should be rocked down so that the base of the triangle fits in the groove between the patient’s lower lip and chin. If it does not fit in this way, the mask may be an inappropriate size or may need to be repositioned.
3. With your nondominant hand, place your thumb on the mask over the bridge of the patient’s nose, and your index finger on the mask over the patient’s lower lip, forming a “C” shape around the mask-valve opening.
4. With your little, ring and middle fingers, grasp the underside of the patient’s mandible.
5. Pull upward with the fingers on the jaw. To form a tight seal, the mandible should be pulled up toward the mask rather than pushed onto the patient’s face. With your dominant hand, fully compress the bag to deliver a breath. If you become tired, you can reverse your hands.

**Two-Person BVM** To perform two-person BVM ventilations, follow these steps:

1. Kneel to the side of the patient’s head (Figure 9-25).
2. Place the mask onto the patient’s face with the apex of the triangle over the bridge of the patient’s nose (as described previously).
3. Place your thumbs alongside the edges of mask. The thumbs and the padded portions of the palm at the base of each thumb should be in contact with the mask.
4. Using the middle, ring, and little fingers of each hand, grasp the underside of the mandible and pull upward. As before, the mandible should be pulled up toward the mask rather than pushing the mask onto the face.

◆ Rescuer #2:
1. Kneel beside Rescuer #1, near the top of the patient’s head.
2. Fully squeeze the bag with both hands to deliver the full volume of air in the bag.

**Pulse Oximetry**

A pulse oximeter is a noninvasive device that evaluates oxygenation at the tissue level by measuring oxygen saturation of hemoglobin in red blood cells (Figure 9-26a). The device has a photoelectric sensing probe that, when clipped onto a finger or an earlobe, measures the oxygenation of the blood in the capillaries (Figures 9-26b and 9-26c). Under normal conditions, oxygen saturation should be above 95 percent when the patient is breathing ambient air at sea level.

Pulse oximetry is a useful tool because it provides quantitative data on the effectiveness of a patient’s ventilation efforts. As a rule, patients with an oxygen saturation of less than 95 percent should be placed on oxygen. Patients with an O₂ saturation of greater than 95 percent but are experiencing difficulty breathing should likewise be placed on oxygen. When administering oxygen to a patient, adjust the flow rate such that an oxygen saturation level greater than 95 percent is achieved.

Pulse oximetry, like other diagnostic instruments, is not foolproof and should not be used as the sole method of assessing oxygenation because false readings can occur. Factors that can cause false readings include nail polish, cold weather, shock, carbon monoxide poisoning, a low red blood cell count, and device malfunction. Clinical assessment of the patient generally is more reliable than a pulse oximeter. Thus even if pulse oximetry indicates that a patient’s oxygen saturation is 100 percent, if they are visibly in respiratory distress, administer supplemental oxygen as allowed by local protocol.

**Gastric Distention**

Whenever artificial ventilations are provided, it is common for the patient’s stomach to fill with air, which can lead to abdominal bloating, a condition more properly known as **gastric distention**. This condition occurs when the amount of ventilatory pressure exceeds the pressure keeping the opening of the esophagus closed, causing...
Partial or total obstruction of the upper airway also can cause gastric distention to occur. The condition is more common in children than in adults but can be prevented by administering slow, gentle breaths or by squeezing the bag over two full seconds.

Gastric distention is not without complications. It can cause vomiting or more-injurious aspiration of gastric contents into the lungs. In addition, gastric distention can restrict movement of the diaphragm, which can decrease the effectiveness of ventilations.

If the stomach becomes distended, make sure the airway is open. Do not push on a distended stomach because the result is nearly always vomiting, which can lead to aspiration of the vomit. If the patient does vomit, place the patient on his side, suction the airway, and then resume rescue breathing.

STOP, THINK, UNDERSTAND

Multiple Choice
Choose the correct answer.

1. Pulse oximetry provides rescuers with what data? ____________
   a. Hematocrit level
   b. Patient’s respiratory rate
   c. Absolute data to determine whether or not oxygen administration is needed
   d. Quantitative data regarding the effectiveness of a patient’s ventilatory efforts

2. Under normal conditions and when breathing ambient air, in what range should a healthy individual’s pulse oximetry level fall? ____________
   a. 72–80 percent
   b. 82–90 percent
   c. 92–100 percent
   d. OEC Technicians cannot rely on pulse oximetry levels due to the adverse environment in which these parameters are usually measured.

3. Which of the following statements about gastric distension is true? ____________
   a. It can be caused by artificial ventilations.
   b. It is caused when ventilatory pressure exceeds the pressure holding the opening of the esophagus closed.
   c. It is more common in children than adults.
   d. All of the above are true.

Fill in the Blank

1. The three oxygen delivery adjuncts are ____________, ____________, and ____________.

2. Some of the factors that can cause false pulse oximetry readings are ____________.

CASE DISPOSITION

You insert an OPA and begin providing artificial respirations using a pocket mask. As other providers and equipment arrive, you request that another OEC Technician assist you in two-man ventilation using a BVM, and you suction the patient as needed. You assist the team in immobilizing the patient’s head and spine and placing him onto a toboggan. His arm was splinted. He is then transported to a waiting ambulance. You later learn that the patient had a severe head injury. The neurosurgeon who treated the patient credits you and your team for your effective airway management, without which, she states, the patient would have died.
OEC SKILL 9-1 Suctioning a Patient’s Airway

a. Open and clear the patient’s mouth.

b. Insert the tip of the catheter no farther than the base of the tongue, making sure you can still see the tip of the catheter.

c. Suction while withdrawing the tip; suction for 10–15 seconds at a time in an adult.
OEC SKILL 9-2 Inserting a Nasopharyngeal Airway

a. Measure the nasopharyngeal airway.

b. Moisten the airway with a water-soluble lubricant.

c. Insert the airway with the bevel toward the base of the tonsil.

d. A nasopharyngeal airway that is properly placed.
OEC SKILL 9-3 Inserting an Oropharyngeal Airway

a

Size the airway by measuring from the corner of the mouth to the ear.

Copyright Scott Smith

b

Insert the airway using the crossed-finger technique to open the mouth.

Copyright Scott Smith

c

Check for airway patency by ventilating the patient.

Copyright Scott Smith
OEC SKILL 9-4 Oxygen Tank Set-Up and Breakdown

a. “Crack” the main valve for 1 second.

b. Select the correct pressure regulator and then place the cylinder valve gasket on the regulator oxygen port.

c. Make certain that the pressure regulator is closed.

d. Align pins (left) or thread by hand (right).

e. Tighten the T-screw for a pin yoke . . .

f. . . . or tighten a threaded outlet with a wrench or key.
Chapter 9: Airway Management

**Bleed the flow meter:** turn the oxygen flow knob counter-clockwise (open) until you no longer hear air escape. Check the pressure gauge to ensure that the pressure is at "0" psi.

**Remove the delivery device.**

**Adjust the flow meter.**

**Turn the cylinder on by opening the main valve.**

**Discontinuing oxygen:** close the main valve.

**Bleed the flow meter:** turn the oxygen flow knob counter-clockwise (open) until you no longer hear air escape. Check the pressure gauge to ensure that the pressure is at "0" psi.
Date: __________________

(CPI) = Critical Performance Indicator

Candidate: ______________________________________

Start Time: ______________________________________

End Time: ______________________________________

**Suctioning a Patient’s Airway**

**Objective:** To demonstrate proper suctioning of a patient’s airway

<table>
<thead>
<tr>
<th>Skill</th>
<th>Max Point</th>
<th>Skill Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate Standard Precautions.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Make sure the suctioning unit is properly assembled and turn on the unit if using a power system.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pre-oxygenate patient prior to suctioning.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Open the patient’s mouth and insert the catheter only as far as you can see.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Apply suction in a side to side or circular motion as you withdraw the catheter.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Do not suction an adult for more than 15 seconds.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
</tbody>
</table>

Must receive 4 of 6 points

Comments: __________________________________________ ___________________________________________________________

Failure of any of the CPI’s is an automatic failure.

Evaluator: ______________________________ NSP ID:______________________________________________________________

PASS    FAIL
**Inserting Nasopharyngeal Airway (NPA)**

**Objective:** To properly insert a Nasopharyngeal Airway into a patient

<table>
<thead>
<tr>
<th>Skill</th>
<th>Max Point</th>
<th>Skill Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate Standard Precautions.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Size the airway. Place the flange against the nostril, and the end should touch the patient’s lower earlobe. Coat the tip and the entire length with a water-based lubricant.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Insert the lubricated airway into the larger nostril with the curvature following the floor of the nose. If you are using the right nare, the bevel should face the septum. If using the left nare, insert the airway with the tip of the airway pointing upward, which will allow the bevel to face the septum.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Gently advance the airway. If using the left nare, insert the nasopharyngeal airway until resistance is met. Then rotate the nasopharyngeal airway 180 into position. This rotation is not required if using the right nostril.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Continue until the flange rests against the skin. If you feel any resistance or obstruction, remove the airway and insert it into the other nostril.</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Must receive 4 of 5 points

Comments: ____________________________________________________________________________________________________

Failure of any of the CPI’s is an automatic failure.

Evaluator: __________________________ NSP ID: __________________________

PASS        FAIL
Inserting an Oropharyngeal Airway (OPA)

Objective: To measure and insert an Oral Airway into an adult

<table>
<thead>
<tr>
<th>Skill</th>
<th>Max Point</th>
<th>Skill Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiate Standard Precautions.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Hold the adjunct against the side of the face with flange adjacent to the corner of the patient's mouth. Size the airway by measuring from the patient's earlobe to the corner of the mouth or from corner of the mouth to the angle of the jaw.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Open the patient's mouth with the cross-finger technique. Hold the airway upside down with your other hand. Insert the airway with the tip facing the roof of the mouth and slide it in until it is half way into the mouth.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
<tr>
<td>Rotate the airway 180°. Insert the airway until the flange rests on the patient's lips.</td>
<td>1</td>
<td>(CPI)</td>
</tr>
</tbody>
</table>

Must receive 4 of 4 points

Comments: __________________________________________

Failure of any of the CPI's is an automatic failure.

Evaluator: ______________________________ NSP ID:____________________________________________________________

PASS    FAIL
Date: ______________
(CPI) = Critical Performance Indicator
Candidate: ______________________________________
Start Time: ______________________________________
End Time: ______________________________________

Preparation an Oxygen Cylinder for Use & Break Down

**Objective:** To prepare a new O2 tank and apply the regulator for use

<table>
<thead>
<tr>
<th>Skill</th>
<th>Max Point</th>
<th>Skill Performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect the tank, regulator, and O ring or washer for any visible damage.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Using an oxygen wrench or the valve stem on the top of the cylinder turn the valve counter-clockwise to slowly “crack” the cylinder for 1 second.</td>
<td>1 (CPI)</td>
<td></td>
</tr>
<tr>
<td>Attach the regulator/flow meter to the valve stem using the two pin-indexing holes and make sure that the washer is in place over the larger hole. Do not overtighten.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Open the O2 system by turning the valve stem on top of the cylinder or using the wrench, counter-clockwise.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Check for/correct any leaks. Check for adequate pressure in tank.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Attach the oxygen connective tubing to the flow meter.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Set the regulator to the proper flow based on the delivery device.</td>
<td>1 (CPI)</td>
<td></td>
</tr>
<tr>
<td>Secure the bottle from falling.</td>
<td>1 (CPI)</td>
<td></td>
</tr>
<tr>
<td>Close regulator and release pressure from tank.</td>
<td>1 (CPI)</td>
<td></td>
</tr>
<tr>
<td>Remove regulator from tank.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Must receive 8 of 10 points and perform all CPI’s.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments:________________________________________

Failure of any of the CPI’s is an automatic failure.
Evaluator: ______________________________ NSP ID: ______________________________________________________________

PASS  FAIL
Multiple Choice

1. What is the purpose of the three-hole system on medical oxygen cylinders? __________
   a. It has no purpose beyond correctly and securely attaching the regulator to the cylinder.
   b. It ensures that no other type of gas can inadvertently be administered to a patient requiring oxygen.
   c. It limits the maximum flow rate on a cylinder to between 2,000 and 2,200 psi.
   d. It fixes the flow rate on a cylinder to 15–25 LPM at 40–70 psi.

2. How long will an oxygen supply last (what is the duration of flow) on a D cylinder that contains 1,500 psi and is set at a flow rate of 15 LPM? __________
   a. Less than 10 minutes
   b. Just under 15 minutes
   c. Between 20 and 30 minutes

Remember...

1. Airway management is a skill that every OEC Technician must master. PRACTICE OFTEN! The head-tilt chin-lift method is the preferred technique for medical patients; the jaw thrust must be used for trauma patients with a head or neck injury and may be used on medical patients. The recovery position can help keep a patient's airway clear.
2. NPA insertion is easy when you use “SLIC.”
3. An OPA should be inserted only in a patient who does not have a gag reflex.
4. A barrier device should be used to provide rescue breaths until the arrival of a bag-valve mask and oxygen.
5. A nasal cannula can deliver 24–44 percent oxygen at 1–6 LPM.
6. A nonrebreather mask can deliver 80–90 percent oxygen at 10–15 LPM.
7. A BVM can deliver 80–100 percent oxygen at 12–15 LPM.
8. Continually monitor the airway to ensure that it remains open and clear.

Chapter Questions

Chapter Summary

The ability to manage a patient's airway is among the most important and fundamental skills every OEC Technician must master. Without an intact, open, and clear airway, a patient will quickly die. As a result of their training, OEC Technicians have several options to open, clear, and maintain a patient's airway. In addition, they are able to provide a patient with supplemental oxygen using a variety of different delivery devices. The combination of these skills and adjuncts are all critical for ensuring that a patient's airway and breathing are preserved. By mastering airway procedures and initiating them quickly when indicated, patient survival can dramatically increase.


**Fill in the Blank**

1. Indicate whether you would use “jaw thrust” or “head tilt-chin lift” as the preferred method in each of the following situations:
   a. __________An unresponsive 20-year-old snowboarder who overshot a terrain park feature and landed on his head
   b. __________An 8-year-old who choked on a pretzel
   c. __________A 14-year-old drowning victim
   d. __________A 17-year-old mountain biker whose mouth is full of blood and broken teeth after he flipped over his handlebars and landed on a boulder
   e. __________A 52-year-old female who has suffered a major heart attack
   f. __________A 27-year-old female who landed head first after falling off her horse

2. Indicate which of the following airway adjuncts should be used for each of the following tasks:
   1. suction
   2. nasal cannula
   3. nonrebreather
   4. bag-valve mask
   5. pocket mask
   6. barrier shield
   a. Clearing an airway of vomitus
   b. Administering low-flow, passive oxygen to a patient
   c. Administering oxygen at 1–6 LPM, with 2–4 LPM being typical
   d. Can deliver 80–90 percent oxygen
   e. Can deliver 80–100 percent oxygen
   f. Best device for use on a patient feeling claustrophobic or panicked
   g. Best used for trauma patients who can breathe well on their own
   h. Requires filling of a reservoir bag before use
   i. Used in conjunction with an oropharyngeal airway on an unresponsive, unresponsive patient
   j. Used at a flow rate of 10–15 LPM
   k. Used to clean vomit out of the mouth
   l. Used to ventilate a patient manually when supplemental oxygen, a BVM, a mask, or a nasal cannula are not available

3. A patient who has suffered a major loss of blood and requires high-flow oxygen through a nonrebreather mask is refusing to allow you to place the mask on his face. What should you do?

---

**Scenario**

You are dispatched to aid a skier who has fallen and struck a snow-making machine. Because you are the first to arrive, you secure the scene. A 16-year-old unresponsive female is draped over the machine. Her head is bloodied. You assess her airway, and she is not breathing.

1. What should you do? __________
   a. Make sure she isn’t moved until help arrives and proper c-spine procedures can be applied.
   b. Apply direct, firm pressure to the wound on her head to control the bleeding.
   c. Carefully put her in a position that will enable you to secure an airway using the jaw-thrust technique.
   d. Open the airway with a tongue blade.
You call for a toboggan, a backboard, the trauma pack, and an ALS unit. The requested help arrives. The patient's airway is patent, and she is breathing at 8 breaths per minute and shallow. You decide to insert an OPA to secure the airway.

2. How should you measure for the correct size of the oropharyngeal airway? __________
   a. From the bottom of the ear to the middle of the mouth
   b. From the bottom of the ear to the tip of the nose
   c. From the bottom of the ear to the corner of the mouth
   d. From the center of the ear to the center of the mouth

The toboggan and trauma pack now arrive. When attempting to insert the OPA, you are prepared for vomiting and have the manual suction pump assembled and at the patient's side. As the OPA is inserted, the patient presents with a gag reflex.

3. Your response to the gag reflex is to __________
   a. remove the OPA and suction any vomitus material.
   b. remove the OPA and attempt to reinsert a smaller size.
   c. place the patient in the left lateral recumbent position.
   d. place the patient in a prone position.

You remove the OPA, and the team uses a bag-valve mask with high-flow oxygen to assist the patient's breathing at a rate of one breath every six seconds.

You decide an NPA is the adjunct of choice, and using a water-soluble lubricant you insert the device with the bevel toward the septum in the larger nostril.

4. Before insertion, the NPA is measured __________
   a. from the earlobe to the edge of the mouth.
   b. from the top of the ear to the middle of the nostril.
   c. from middle of the ear to the middle of the nostril.
   d. from the tip of the nose to the patient's earlobe.